IL550 & IL560 Series Optical Monitors

for

The ULTIMATE in Thin Film Coating Precision, Accuracy & Control
Why Use Optical Monitoring?

- Quartz crystal measures the deposited mass
  - Typical accuracy ± 1% - actual error increases with thickness and layer complexity

- Optical Monitoring measures the true **Optical Thickness**

- Inherent error compensation in optical monitoring
  - Film stack errors can **decrease** as layer thickness and complexity increases

- Achievable repeatability ± 0.01%
  - **Example**
    - 34 layer non-QW design bandedge filter
    - Bandedge repeatability run-to-run over many days
      - ± 1.6nm without Optical Monitoring (Crystal Monitoring only)
      - ± 0.1nm with Optical Monitoring

- Optical Monitoring is becoming the preferred solution for a wide range of precision optical components
  - Need to use crystal monitoring in conjunction with Optical Monitor in order to control deposition rates.
Optical Monitoring Vs Quartz Crystal Example

Target Specification

- Product:
  High Performance Steep Edge Notch Filter

- Application:
  Laser Protection Filter

- Materials:
  TiO$_2$ / SiO$_2$
  Ebeam deposition and IAD

- Film Stack Design:
  Demanding 30+ layer film stack with non-QW termination

- Band Edge Position Spec: ± 0.7 nm
Optical Monitoring Vs Quartz Crystal Example

Performance of film stacks produced over many growth runs using Quartz Crystal Monitoring compared with those produced using Intellevation’s IL551 Optical Monitor.

Band Edge Position
Quartz Crystal Monitoring

Band Edge Spread > 3.3 nm
Poor Yield

Band Edge Position
Optical Monitoring

Band Edge Position ± 0.1 nm
Very High Yield
IL550 Series of Optical Monitors

- Add Precision, Accuracy & Certainty to YOUR Coating Process
- Provide real-time cutpoint capability for a wide range of precision optical coating applications.
- Automatically provides a cut based on a pre-programmed optical thickness for each film
- Automatically adjusts the monitoring wavelength for each layer
- Can cut either ‘On’ QW or ‘Off’ QW
- Supplied with a powerful suite of software to create one integrated precision coating monitor tool.

- Increase customer’s product Performance !
- Increase customer’s Yield !
- Drive down customer’s Costs !
Applications: 300 nm to beyond 12 μm

Simple Coatings
- Simple AR
- Broadband AR
- Crystal Monitor alone

Complex or Precision Coatings
- Beamsplitters
- Reflectors
- Laser Facets AR & HR
- Gain Flattening Filters
- Bandpass Filters
- DWDM Filters
- Longpass Filters
- Shortpass Filters
- Optical Monitor & Crystal Monitor Combination
Monitoring On Your System: Box Coaters

Front Surface Reflection

Back Surface Reflection

Transmission

Coating Chamber

Source

Detector
Monitoring On Your System: Drum Coaters

Sputter Drum Coater

Fibre Based Optical Monitor System

Controller / Processor Module

Intellevation

IL560 Optical Monitor
### IL550 Series Module Options

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<th>Waveband (nm)</th>
<th>Detector</th>
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<td>300-800</td>
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<table>
<thead>
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<th>Source Module</th>
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<td>IL550S</td>
<td>300-2400</td>
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Source
(Common to all four models)

Detector

Computer / Controller
(Common to all four models)
Accessories: Test Glass Changers

- In-house designs. Customised for your chamber geometry.
- Driven from IL550 Optical Monitor system for true integration and automation.
- Optional Integrated Multiposition Crystal Changer.
- Suitable for front or back face reflection and transmission optical monitoring modes.
- Optical alignment from outside the chamber, i.e. under vacuum.
Advanced Measurement System

- Free space optical method utilising;
  - High speed 4 phase chopped light source for high rate, low noise data collection in harsh coating environments.
  - Synchronous detection of Sample, Dark and Reference signals.
  - Signal and Reference share a common optical and electronic path for maximum drift immunity. Similar to a dual beam spectrophotometer.
  - Full digitisation at the Detector Module for maximum electrical noise immunity.
  - Wavelength discrimination post chamber for maximum process induced optical immunity.

- Result: Robust precision measurement on YOUR system!
Powerful Software

The IL550 Series of Optical Monitors give thin-film engineers the tools to decrease process development time & manufacturing costs AND increase yield & product performance.

The system combines advanced optoelectronic hardware with a suite of powerful software packages including:

- **FilmMaker ©**
  - FilmBuilder ©
  - FilmModeller ©
  - FilmSimulator ©
  - FilmCharacters ©
  - FilmReviewer ©
- **FilmDirector ©**

...to provide a single complete integrated solution.
Predictive modelling software – design a film structure from scratch and rapidly determine the optimum process conditions thereby reducing material waste & process development time.

Key Features
- Modelling allows the selection of optimum monitor wavelength & test glass for each layer.
- Single data entry screen
- Rapid input for QW stacks
- On screen help prompts
- Automatic & manual modes
- Automatic gain setting
- Simple (default) and Advanced screens
- Import and export of files
- Data consistency check
FilmModeller

- Automatically reads a FilmBuilder® file
- Calculates and displays the expected Optical Signal as a function of Deposition Time
- Snapshot of whole process
- Rapidly see the effect of your model design
- Provides guide to signal compression
- Provides guide to number of films per test glass.
- Suggests OM scheme options to try in FilmSimulator®

Non QW stack

QW stack
**FilmSimulator**

- **UNIQUE and POWERFUL feature not found in other packages**

- Off-Line simulation runs including
  - Optical Model
  - Physical effects of Optical Monitoring hardware
  - Physical effects of Customer’s Coating Tool
    - E-gun noise (material dependent)
    - Gun dep rate control
    - Test glass variations

- Calculates ‘cut point’ errors on a layer-by-layer basis

- See inside the process and identify where errors will occur

- Helps the coating engineer design a ROBUST process off-line
FilmSimulator © in Action

- Complex 26 layer film stack
- Multiple Non Quarter Wave design
- FilmSimulator © indicates cutpoint errors > 50%
- Proof that the product will be extremely unlikely to meet specification

**Action:** Modify growth scheme and analyse impact with FilmSimulator ©

Same film stack – different scheme

- Change monitor wavelengths
- Change Test Glass scheme
- Change filter settings
- Change QW factors
- Change number of samples per QW

**Result:** massive decrease in cutpoint errors (< 1%)
- the film stack performance is now achievable!

1 hour on FilmSimulator © saves many days of process development on the production line.
- Determine the Spectral Characteristics of the final film stack
- Compare the THEORETICAL DESIGN spectra with the ‘REAL-LIFE’ spectra from FilmSimulator ©
- See the impact of ‘cut point’ errors on the performance of your final product !
- Powerful production process design tool
- Plot many simulated runs on the same graph
  - gain real information on process YIELD – OFFLINE !

Complex non-quarter wave design. FilmCharacters© shows the designed response and the run-to-run variability – even before a run is done.
FilmDirector ©

- A fast and easy-to-use front-end that enables you to drive your process.
- Loads a process from FilmMaker ©

- Performs the run under automatic or manual control as required
- Autocalibrates on start up
- FilmDirector © automatically changes the wavelength and the test glass
- Detects each cut and controls the material sources and shutters through an advanced I/O capability.
**FilmDirector ©**

**Key Features**

- Incorporates advanced model fitting algorithms for cutpoint determination
- State machine based controller can recover/continue a process context even after a shutdown.
- Integrates seamlessly with **FilmMaker ©** design front-end.
- Freely configurable, panelled user-interface.
- Now includes two operating modes.
  - **ADVANCED** mode for process developers allows access to all of the parameter space.
  - **BASIC** mode enables an ADVANCED user to lock and hide many of the advanced parameters thereby providing a clear front-end for a previously optimised process, ideal for use by operators in a manufacturing environment.
- After a run is completed, the data is logged for later analysis. Files can be exported in CSV format for analysis in your favourite program.
*FilmReviewer* © is used to view, analyse and reprocess previous runs – for **OFF-LINE OPTIMISATION**.

- Take **REAL RAW DATA** from your coating system, and observe the effects of reprocessing it, changing the filtering parameters, the sampling rate, the latency and hold-off parameters and the termination algorithms.

- **OFF-LINE OPTIMISATION**
  - Load RAW DATA from previous runs on a layer by layer basis
  - Reprocess the data on a layer by layer basis to optimise future runs
  - View the raw data for the whole stack or analyse a layer at a time
  - Change Acquisition Settings, Turning Point Analysis Settings and Analyser Mode and see the impact on accuracy of cutpoint determination.
Installation

Our skilled engineers will install and commission our monitor systems directly onto your coating system ✔

at your facility ✔

and provide initial on-site operational training ✔
Training & Support Products

Intellevation’s growth and optical monitoring experts provide:

- **Post Installation Training Packages**
  - Face-to-face training at the customer’s facility…
  - On the customer’s coating machine…
  - Tailored to the customer’s specific experience & process…
  - Duration determined by customer’s needs…
  - Aims to provide customer with the necessary practical experience in coating machine set-up, optical monitoring, and optical process design to rapidly achieve their precision coating goals.

- **In-House Training Packages**
  - As above but at our coating facility using our equipment…

- **Process Development Packages**
  - Theoretical thin film design, and growth scheme design consultancy…
  - On the customer’s coating machine…
  - Tailored to the customer’s specific experience & process.
Thank You

For further information or support, please contact

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